Title: Identification of Human Fetal Brown Adipose Tissue using MRI

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Structured Abstract:

Introduction: Brown adipose tissue (BAT) and white adipose tissue (WAT) have different functions and therefore give different insight into the metabolic health of an individual. BAT is responsible for non-shivering thermogenesis and is crucial to maintaining the body temperature of newborns who lack the ability to shiver. WAT is primarily an energy-storage organ and provides insight into the energy balance of the fetus. Due to these differing roles, identification of these two tissues is important when examining fetal adipose tissue. We hypothesize that there will be differences in the PDFF, T2*, and T1 values between fetal BAT and fetal WAT.

Methods: Participants with singleton pregnancies (excluding diabetics and those with growth restricted fetuses) were imaged in a wide bore (70 cm) 1.5T MRI (GE MR450w). During an approximately 30 min MRI exam, two 3D water-fat MRI (Quantitative IDEAL, TR 9.7-12.7 ms, flip angle 6° or 20°, Field of View 50 cm, 160x160 pixels, slice thickness 4-6.5 mm, 42-78 slices, ARC acceleration 2x phase 2.5x slice and 32x32 calibration lines, acquisition time 12-24 s) was used to image fetal adipose tissue during two maternal breath holds. The fetal adipose tissue around the kidneys (perirenal) was manually segmented as a known site of BAT. The subcutaneous adipose tissue around the fetal abdomen and upper arm was manually segmented to represent WAT. The median PDFF and mean T2* values were measured in these compartments from the 6° image set. Mean T1 values were calculated from the two acquisitions using DESPOT1. Linear regression was performed between gestational age (GA) and MRI measures for each compartment, then slopes and intercepts of the linear regressions were compared.

Results: 24 women were included in the study with GA at MRI between 29 and 38 weeks. The perirenal adipose compartment was not visible before 32 weeks, while we could identify the subcutaneous adipose tissue in all our participants. The PDFF increased with GA all three compartments, and the slopes are not significantly different (p = 0.36), but the intercepts were significantly different (p < 0.0001). The linear regressions of T2* with GA gave slopes and intercepts that are not significantly different (p = 0.11 and p = 0.11 respectively). Similarly, T1 values did not have significantly different slopes and intercepts (p = 0.39 and p = 0.31 respectively).

Discussion and Conclusion: The difference in intercepts between perirenal (BAT) and arm (WAT) compartments suggests that PDFF can help distinguish BAT from WAT in the fetus. T2* and T1 did not have different slopes or intercepts between BAT and WAT, however with a larger sample size they may also contribute to distinguishing fetal BAT from WAT. In the future, fatty-acid saturation measurements may provide useful information to aid in the differentiation of fetal BAT from WAT with MRI. In conclusion, PDFF measurements may be able to distinguish BAT from WAT in the fetus.